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Description

The present invention relates to a heat cooking apparatus according to the preamble of claim 1 (see JP-A-57-150731).

A so-called grill oven range as referred to above is generally so arranged to heat an object or food article to be cooked within a heating chamber by microwave energy, and also, to form scorching or burning on the surface of the food article by heat rays of an electric heating means or electric heater.

Conventionally, for adjusting the state of scorching in the grill heating in such a grill oven range, it has been a general practice that a cooking person manually turns on or off the electric heater through visual examination on the surface of the food article, or sets a timer of the electric heater in addition to the heating time of the food article obtained by experience. Meanwhile, as a new practice, there has been recently proposed a method in which visible light rays from a light source are projected onto a food article being heated, and the light amount of the visible light rays reflected by the food article is detected by a photo-detector so as to judge the state of scorching based on the variation with time of the detection signal, whereby heating by the electric heater is suspended upon arrival at a predetermined state of scorching, as disclosed, for example, in Japanese Patent Laid-Open Publication Tokkaisho No. 58-140524 or Tokkaisho No. 57-150731.

Although the above new practice is an epoch-making process in that the reduction of light amount of the reflected visible light rays favorably corresponds to the progress of scorching, there is such a disadvantage that, in spite of the fact that shapes of food articles to be subjected to the grill heating differ in various ways and there is a large difference in the tone of shade before and after the heating as in meat and fish, etc. with consequent variations in the reflected light amount, no particular countermeasures are taken therefor, and only the reflected light amount is regarded as a judging standard of the state for scorching. Accordingly, it is difficult to accurately judge all the states of scorching for various food articles, thus resulting in over-scorching or insufficient scorching depending on the kinds of food articles to be dealt with.

Furthermore, in the above new practice, since a photodiode is employed as a photo-detector for detecting the reflected light amount, the detection signal tends to be drifted to a large extent as it is affected by high ambient temperatures in the vicinity of the heating chamber, thus requiring a cooling device or complicated temperature compensating circuit for the prevention thereof, or necessitating an amplifier due to a low level of the detection signal, with consequent complication in the construction of the apparatus and increase in cost on the whole.

GB-A-2184834 discloses a cooking apparatus comprising a first and a second thermistor. The resistance value of the first thermistor is regulated by a detecting circuit. The output of the detecting circuit is adjusted to zero over a large temperature range. A microcomputer controls the cooking operation depending on the outputs of the detecting circuit and the second thermistor.

SUMMARY OF THE INVENTION

Accordingly, an essential object of the present invention is to provide a heat cooking apparatus which is capable of controlling grill heating so as to form optimum scorching on a food article by accurately judging state of scorching of various food articles during the grill heating, through employment of a photo-detector means other than a photodiode or a plurality of detecting means.

Another object of the present invention is to provide a heat cooking apparatus of the above described type which is simple in construction and stable in functioning, and can be readily manufactured at low cost.

The heat cooking apparatus of the present invention comprises the features of the appended claim 1.

More specifically, in the invention, the temperature sensor employed in Japanese Patent Laid-Open Publication Tokkaisho No. 57-150731 is omitted, and the photo-detector is constituted by the photo-conductive element applied with the constant voltage through the reference resistance connected in series thereto, and varied in the resistance value according to the light amount received, with the specific resistor selected from the plurality of resistors being adapted to be connected in parallel to said reference resistance so that at starting of heating of the food article by the electric heating means, voltage drop values in the photo-conductive element and the reference resistance become approximately equal to each other by the detection sensitivity adjusting means, while only the variation with time of the detecting signal from the photoconductive element after the detection sensitivity adjustment is monitored by the control means.

Meanwhile, in the heat cooking apparatus of the invention, when the electric heating means starts heating the food article within the heating chamber, the photo-conductive element applied with the constant voltage through the reference resistance connected in series thereto, receives the visible light rays emitted from the light source and reflected by the food article so as to output the detection signal corresponding to the received light amount. Simultaneously, the detection sensitivity adjusting means selects the specific resistor from the plurality of resistors for connection in parallel with said reference resistance so that the voltage drop values in the photo-

conductive element and the reference resistance become generally equal to each other. Then, the control means monitors the variation with time of the detection signal from the photo-conductive element after the detection sensitivity adjustment, and judges the heating to be terminated when the detection signal is reduced by the specific value from the maximum value, thereby to control to complete the heating of the electric heating. By the above adjustment of the detection sensitivity, variation of the detection signals due to various factors are corrected, and since the specific values as referred to above may be properly given preliminarily according to a kinds of the food articles to be heated, the respective food articles can be heated through grill heating until the optimum scorching is formed.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects and features of the present invention will become apparent from the following description taken in conjunction with the preferred embodiment thereof with reference to the accompanying drawings, in which;

Fig. 1 is a perspective view of a heat cooking apparatus according to one preferred embodiment of the present invention, with top and side walls removed for clarity,

Fig. 2 is a schematic longitudinal sectional view of the heat cooking apparatus of Fig. 1,

Fig. 3 is a schematic circuit diagram showing, for illustration purposes only, a control means based on a detection signal of a photo-detecting element employed in a heat cooking apparatus,

Fig. 4 is a graphical diagram showing an example of the detection signal referred to in Fig. 3,

Fig. 5 is a schematic circuit diagram showing an essential portion of a heat cooking apparatus according to the present invention, and

Fig. 6 is a graphical diagram showing an example of the detection signal related to the heat cooking apparatus of Fig. 5.

DETAILED DESCRIPTION OF THE INVENTION

Before the description of the present invention proceeds, it is to be noted that like parts are designated by like reference numerals throughout the accompanying drawings.

Referring now to the drawings, there is shown in Figs. 1 and 2, a heat cooking apparatus M1 according to one preferred embodiment of the present invention, which generally includes a housing H having a front wall 1a, a rear wall 1b, and a bottom wall 1c, and also a top wall and side walls removed for clarity in Fig. 1, a heating chamber 1 in a rectangular box-like configuration defined by side plates S1 and S2, and top and bottom plates t and b between the front wall 1a formed with an access opening 0 for selective opening and closing by a door (not shown) and the rear wall 1b, a turn table 2 rotatably provided on a bottom portion within said heating chamber 1 for placing a food article A therein, a magnetron 3 mounted on one side plate S1 of the heating chamber 1 for irradiating microwave energy onto the food article A, and electric heating means or electric heaters 4 provided on the top plate t of the heating chamber 1 for projecting heat rays onto the food article A, a halogen lamp 5 also provided on the top plate t of the chamber 1 for projecting visible light rays onto the food article A, and a photo-conductive element 6 as a photo-detector for detecting light amount of the visible light rays reflected by the food article A.

As is most clearly seen in Fig. 2, the turn table 2 is mounted on a support base 9 to be driven for rotation by a motor 8, with the food article A being placed on the upper surface of the turn table 2 through a net rack 10 or the like. The photo-conductive element 6 constituted by CdS (cadmium sulfide) is fixedly mounted slantwise through a support member 11 at the upper portion of one side plate S1 of the heating chamber 1 so as to receive visible light rays emitted by the halogen lamp 5 and reflected by the food article A as shown by a dotted line arrow in Fig. 2. The heat cooking apparatus M1 further includes a microcomputer 16 (Figs. 3 and 5) as a control means for controlling the electric heating means 4 based on monitoring of variation with time of detection signals from the photo-conductive element 6.

As shown in Fig. 3, the microcomputer 16 receives, at its A/D port A1 through a filter 18 including a resistor R2 and a capacitor C1, a voltage drop V1 of a reference resistor 17 (resistance value R1) applied with a constant voltage Vc through the photo-conductive element 6 (resistance value Rc) connected in series thereto. In the voltage drop V1 represented as

$$V1 = R1 \cdot Vc/(R1 + Rc),$$

since Rc is reduced as the amount of light reception of the photo-conductive element 6 is increased, the voltage drop V1 is increased or decreased according to the increase or decrease of the received light amount.

Fig. 4 shows one example of the variation with time of the above voltage drop to be inputted to the A/D port A1 so as to be converted into the digital value, during heating of the food article A by the electric heating means 4. More specifically, as shown by a curve A1 in Fig. 4, after being rapidly increased transitionally upon turning on of a power supply for the electric heating means 4, the detection level of the photo-conductive element 6 reaches a maximum level B max through gradual increase by the reflection light amount which is gradually increased at the early stage of grill heating, and thereafter, is decreased according to the reflection light amount which is de-

creased as the scorching proceeds. the microcomputer 16 is arranged to hold the above maximum level B max, and to measure and memorize the heating time T1 until the detection level reaches B1 through decrease from the above maximum level B max by the predetermined value ΔB preliminarily given as data according to the kinds of the food article A.

The microcomputer 16 further sets the measured time T1 as a heating completion starting time To so as to multiply To, for example, by K/8 (where K is a factor preliminarily given as a data according to the kinds of the food article) as an additional heating factor for continuing power supply to the electric heating means 4 by the time represented by To×K/8, and thereafter, stops the power supply. The microcomputer 16 is also arranged to gradually decrease the supply power to be zero over the time of To×K/8 or to stop the power supply immediately at the timepoint of the heating completion starting time To according to the set heating completion mode.

Functioning of the heat cooking apparatus M1 as described so far will be explained hereinafter.

Upon turning on the power supply for the electric heating means 4 of the heat cooking apparatus M1, when the electric heating means 4 starts heating the food article A within the heating chamber 1 for grill heating, the photoconductive element 6 receives the visible light rays emitted from the halogen lamp 5 and reflected by the food article A so as to output the detection voltage V, corresponding to the received light amount.

The microcomputer 16 monitors the variation with time (as shown in Figs. 4 and 6) of the detection voltage V1 inputted to the A/D port A1, and measures the heating time T1 until the detection level A1 in Fig. 4 reaches B1 through decrease by the predetermined value ΔB from the maximum level B max, while it also sets the heating time T1 as the heat completion starting time T0, which is multiplied, for example, by K/8 as the additional heating factor. Thus, according to the heating completion mode preliminarily set, the power supply is suspended after continuing energization of the electric heating means 4 by the time To×K/8, gradually reduced towards zero over the time period To×K/8, or immediately stopped at the timepoint of the heating completion starting time To.

By the arrangement of the heat cooking apparatus M1 according to the present invention as described so far, since the factor K for determining the specific value ΔB at the detection level A1 of the photoconductive element 6 can be properly preset according to the kinds of the food articles A to be heated by the grill heating (e.g. meat, fish, or principal food such as rice or the like), the grill heating by the electric heating means 4 is effected until optimum scorching is formed on each food article. Moreover, owing to the arrangement to control the on-time of the electric heating means 4 based on the reflection light amount by the photoconductive element 6, the state of scorching of each food article may be controlled more accurately, thus not giving rise to over-scorching or under-scorching according to the kinds of food articles. Furthermore, the photo-conductive element 6 of CdS employed as the photo-detecting element instead of a photodiode can provide a large detection voltage V2 even without use of an amplifier for simplification of the circuit.

Referring further to Fig. 5, there is shown a circuit diagram representing an essential portion of a heat cooking apparatus M2 according to the present invention.

In the arrangement of Fig. 5, the photo-conductive element 6 and the reference resistance 17 are connected in series in a reverse order with respect to the power supply Vc as shown in Fig. 3, while five resistors R3,R4,R5,R6 and R7 having different resistance values and connected in a parallel relation with respect to the reference resistance 17 are respectively grounded through switches SW1,SW2,SW3,SW4 and SW5, which are subjected to the on/off control by a microcomputer 26 for effecting control similar to that in the embodiment of Fig. 3, thereby to provide a detection sensitivity adjusting means.

Since other construction of the heat cooking apparatus M2 in Fig. 5 is similar to that of the heat cooking apparatus M1 of the embodiment of Fig. 3, detailed description thereof is abbreviated here for brevity of explanation.

The function of the microcomputer 26 as referred to above is as follows.

The microcomputer 25 controls to turn off all the switches SW1 to SW5 at the starting of the heating by the electric heating means 4, and receives, at its A/D port A1, the voltage drop V2 of the reference resistance 17 (resistance value R1) applied with the constant voltage Vc through the photo-conductive element 6 (resistance value Rc). The voltage drop V2 is represented as

$$V2 = R1 \cdot Vc/(R1 + Rc),$$

and since Rc is rapidly reduced by the halogen lamp 5 which is lit upon starting of heating, the detection level A1 of the photo-conductive element is rapidly increased close to Vc as shown in Fig. 8. The microcomputer 26 selects the optimum resistance Ri (i=3-7) so as to set the above detection level at about Vc/2 by turning on the corresponding switch SWi. In other words, the switch SWi by which the initial resistance value Rc of the photoconductive element 6 and the composite resistance value R1Ri/(R1+Ri) of the reference resistance 17 and the resistance Ri become equal to each other, i.e. the switch SWi of the resistor Ri closest to Ri=RcR1/(R1-Rc) in the resistance value is turned on. By the above function, the detection level A1 becomes approximately Vc/2 as shown in Fig. 6, and thereafter, varies along the curve A1 similar to that referred to earlier in Fig. 4. Accordingly, the on/off

control of the electric heating means 4 by the microcomputer 26 based on the detection voltage V1 is generally similar to that described earlier with reference to Fig. 4. Therefore, detailed description thereof is also abbreviated here for brevity.

In the present invention as described above, since it is so arranged to measure the resistance value Rc of the photo-conductive element 6 which largely varies according to manufacturing factors, shape of the food article reflecting light rays, etc. at the early state of heating, and the adjust the detection sensitivity to the optimum state by changing-over the parallel resistors for the control of the heating time through employment of the detection signal after the detection sensitivity adjustment, the respective food articles may be formed with the best scorching, without over-scorching or under-scorching according to the kinds of food articles. Furthermore, through employment of the photo-conductive element 6 of CdS, circuit construction may be advantageously simplified.

Since the photo-conductive element is applied with the constant voltage through the reference resistor connected in series thereto, and varied in the resistance value according to the light amount received, with the specific resistor selected from the plurality of resistors being adapted to be connected in parallel to said reference resistor so that at starting of heating of the food article by the electric heating means, voltage drop values in the photo-conductive element and the reference resistor become approximately equal to each other by the detection sensitivity adjusting means, while only the variation with time of the detecting signal from the photo-conductive element after the detection sensitivity adjustment is monitored by the control means for effecting control, the state of scorching may be accurately judged by the detection sensitivity adjustment even without employment of the temperature in the heating chamber as a control parameter, and thus, the optimum grill heating without over-scorching or under-scorching of food articles can be effected by setting the above predetermined values according to the kinds of food articles, while simplification of the circuit construction and consequent cost reduction may also be achieved through employment of the photo-conductive element such as CdS.

Although the present invention has been fully described by way of example with reference to the accompanying drawings, it is to be noted here that various changes and modifications will be apparent to those skilled in the art. Therefore, unless otherwise such changes and modifications depart from the scope of the present invention, they should be construed as included therein.

Claims

1. A heat cooking apparatus arranged to cook a food article (A) through heating by projecting microwave energy generated by a magnetron (3) and heat rays produced by an electric heating means (4), onto the food article (A) placed in a heating chamber (1), said heat cooking apparatus comprising a light source (5) for projecting visible light rays onto said food article, control means (26) which controls to complete the heating by said electric heating means (4) by judging that the heating is to be terminated when the detection signal is reduced by a predetermined value from a maximum value, a photoconductive element (6) which receives the visible light rays as reflected by the food article,
characterized in that
said photo-conductive element (6) varies its resistance value according to the light amount thereof and is applied with a constant voltage through a reference resistance (17) connected in series thereto, a plurality of resistors (R3 to R7) are selectably connected in parallel to said reference resistance (17), a detection sensitivity adjusting means (SW1 to SW5, 26) is provided for selectively connecting said resistors (R3 to R7) so that voltage drop values in said photoconductive element (6) and said reference resistance (17) become approximately equal to each other, at starting of heating of the food article by said electric heating means (4), and said control means (26) monitors the detection signal from said photoconductive element (6) after the detection sensitivity adjustment.

Patentansprüche

1. Mikrowellengerät, zum Erwärmen eines Lebensmittels (A) in einer Erwärmungskammer (1) mittels durch ein Magnetron (3) erzeugter Mikrowellen-Energie einerseits und durch Wärmestrahlen andererseits, die durch eine elektrische Heizung (4) erzeugt werden, wobei das Mikrowellengerät folgendes aufweist:

eine Lichtquelle (5) zur Projektion sichtbarer Lichtstrahlen auf das Lebensmittel,

eine Steuerung (26), welche die Erwärmung durch die elektrische Heizung (4) beendet, wenn ein Prüfsignal von einem maximalen Wert um einen bestimmten Wert abfällt,

ein photoleitfähiges Element (6), das die vom Lebensmittel reflektierten sichtbaren Lichtstrahlen aufnimmt,

dadurch gekennzeichnet, daß

der Widerstandswert des photoleitfähigen Elements (6) sich entsprechend der auftreffen-

den Lichtmenge ändert, welches über einen in Reihe geschalteten Referenz-Widerstand (17) mit einer konstanten Spannung versorgt wird,

eine Mehrzahl von Widerständen (R3 bis R7) auswählbar parallel zu dem Referenz-Widerstand (17) schaltbar ist,

eine Einstell-Einrichtung (SW1 bis SW5, 26) für die Prüfungsempfindlichkeit vorgesehen ist, um die Widerstände (R3 bis R7) wahlweise so zu verbinden, daß die Spannungs-Abfall-Werte am photoleitfähigen Element (6) und am Referenz-Widerstand (17) zu Beginn der Erwärmung des Lebensmittels durch die elektrische Heizung (4) nahezu gleich werden,

wobei die Steuerung (26) das Prüfsignal des photoleitfähigen Elements (6) nach der Empfindlichkeits-Einstellung überwacht.

Revendications

1. Appareil de cuisson à la chaleur conçu pour cuire un aliment (A) par l'intermédiaire du chauffage en projetant de l'énergie par micro-ondes, produite par un magnétron (3), et des rayons de chaleur, produits par un moyen formant chauffage électrique (4), sur l'aliment (A) placé dans une chambre de chauffage (1), ledit appareil de cuisson à la chaleur comprenant une source de lumière (5) pour projeter des rayons de lumière visibles sur ledit aliment, un moyen de commande (26) qui commande l'achèvement du chauffage par ledit moyen formant chauffage électrique (4) en déterminant que le chauffage doit se terminer lorsque le signal de détection est réduit d'une valeur prédéterminée à partir d'une valeur maximale, un élément photoconducteur (6) qui reçoit les rayons de lumière visibles lorsqu'ils sont réfléchis par l'aliment,

caractérisé en ce que :

ledit élément photoconducteur (6) varie sa valeur de résistance selon la quantité de lumière reçue et en ce qu'on lui applique une tension constante par l'intermédiaire d'un élément de référence (17) relié en série à celui-ci, une pluralité de résistances (R3 à R7) sont reliées, de manière sélective, en parallèle à ladite résistance de référence (17), un moyen de réglage de sensibilité de détection (SW1 à SW5, 26) est prévu pour relier, de manière sélective, lesdites résistances (R3 à R7) de sorte que les valeurs de chute de tension dans ledit élément photoconducteur (6) et dans ladite résistance de référence (17) deviennent approximativement égales l'une à l'autre, au démarrage du chauffage de l'aliment par ledit moyen formant chauffage électrique (4), et ledit moyen de commande (26) suit le signal de détection en provenance dudit élément photoconducteur (6) après le réglage de sensibilité de détection.

Fig. 1

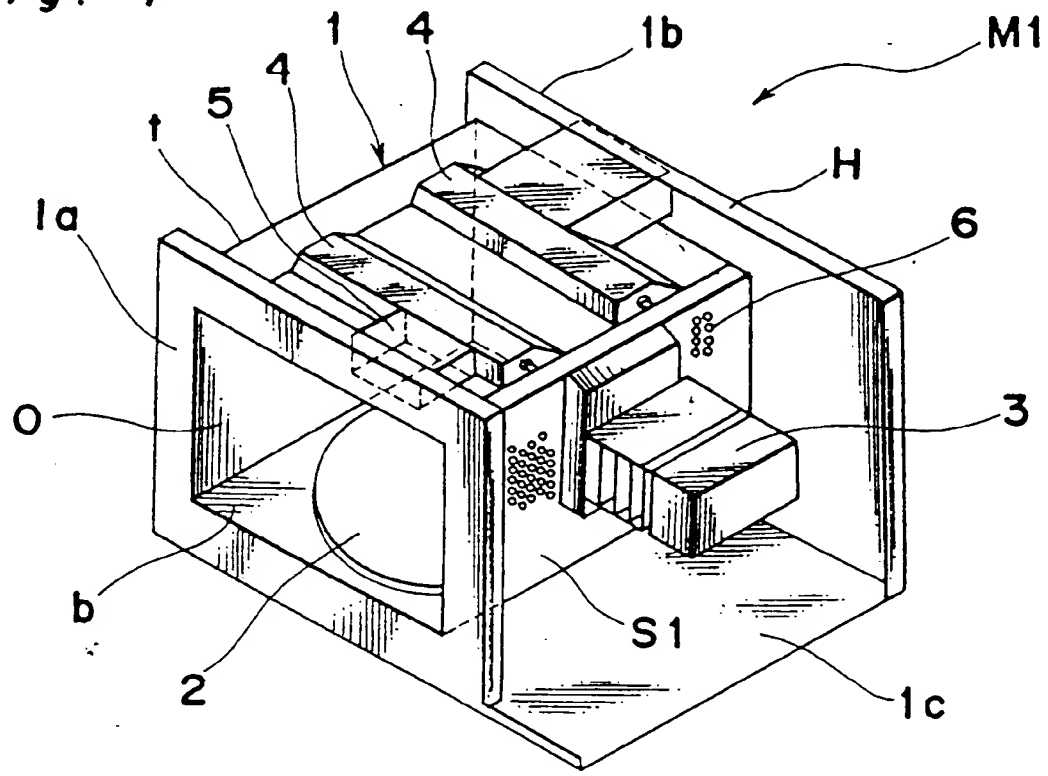


Fig. 2

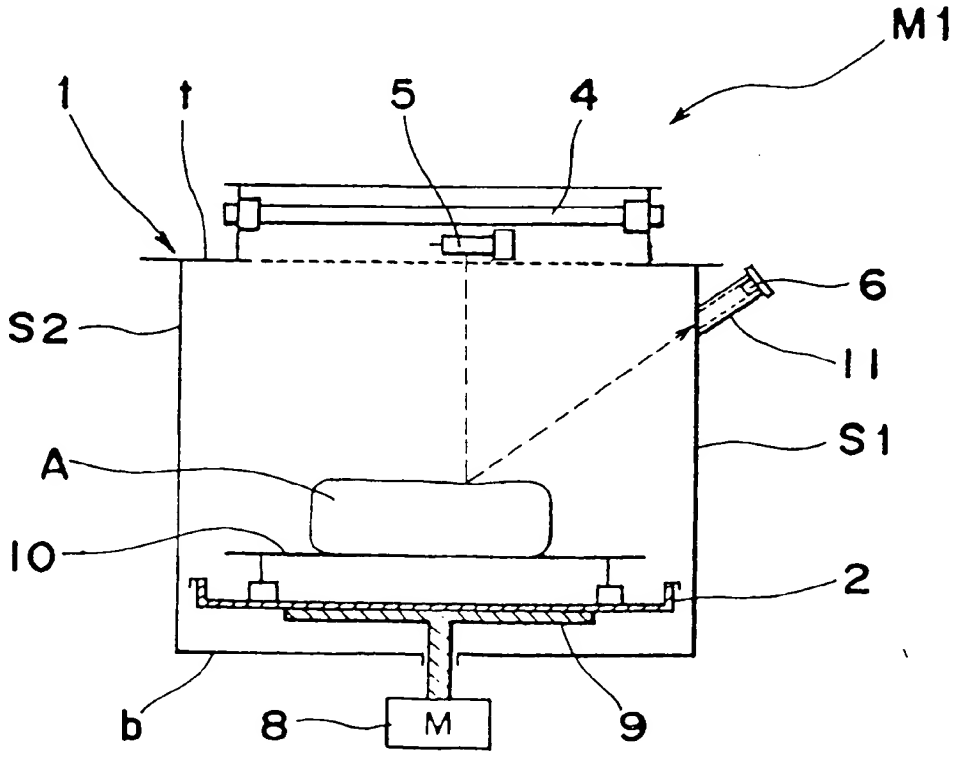


Fig. 3

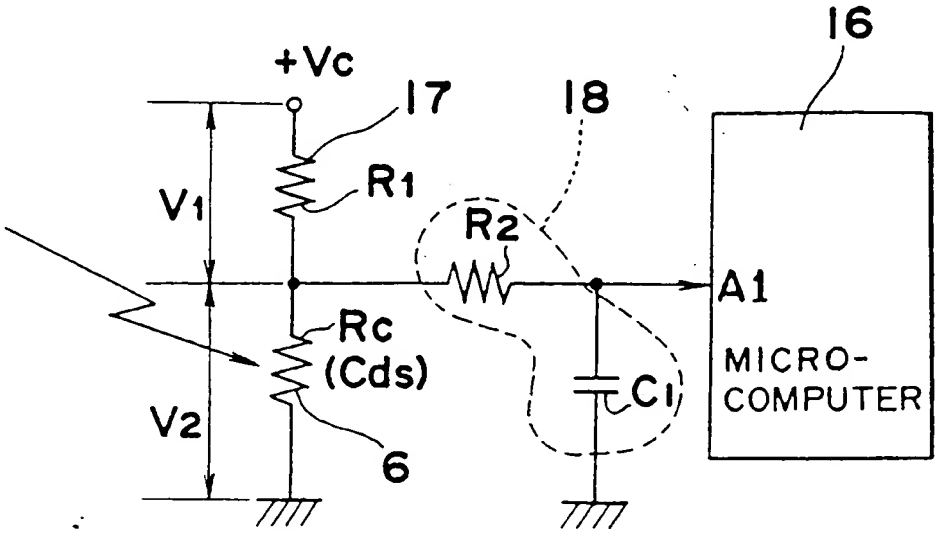

16
+Vc
17
18
R1
V1
R2
A1
Rc
(Cds)
MICRO-
COMPUTER
C1
V2
6

Fig. 4

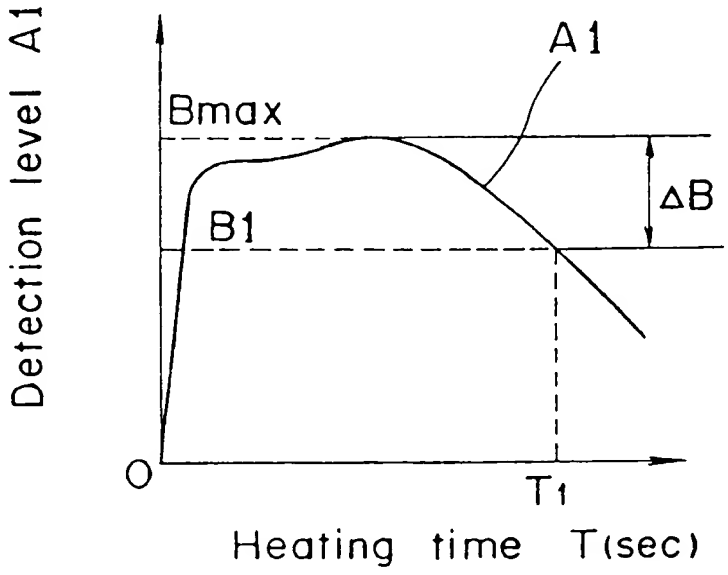

Detection level A1
A1
Bmax
ΔB
B1
O
T1
Heating time T(sec)

Fig.5

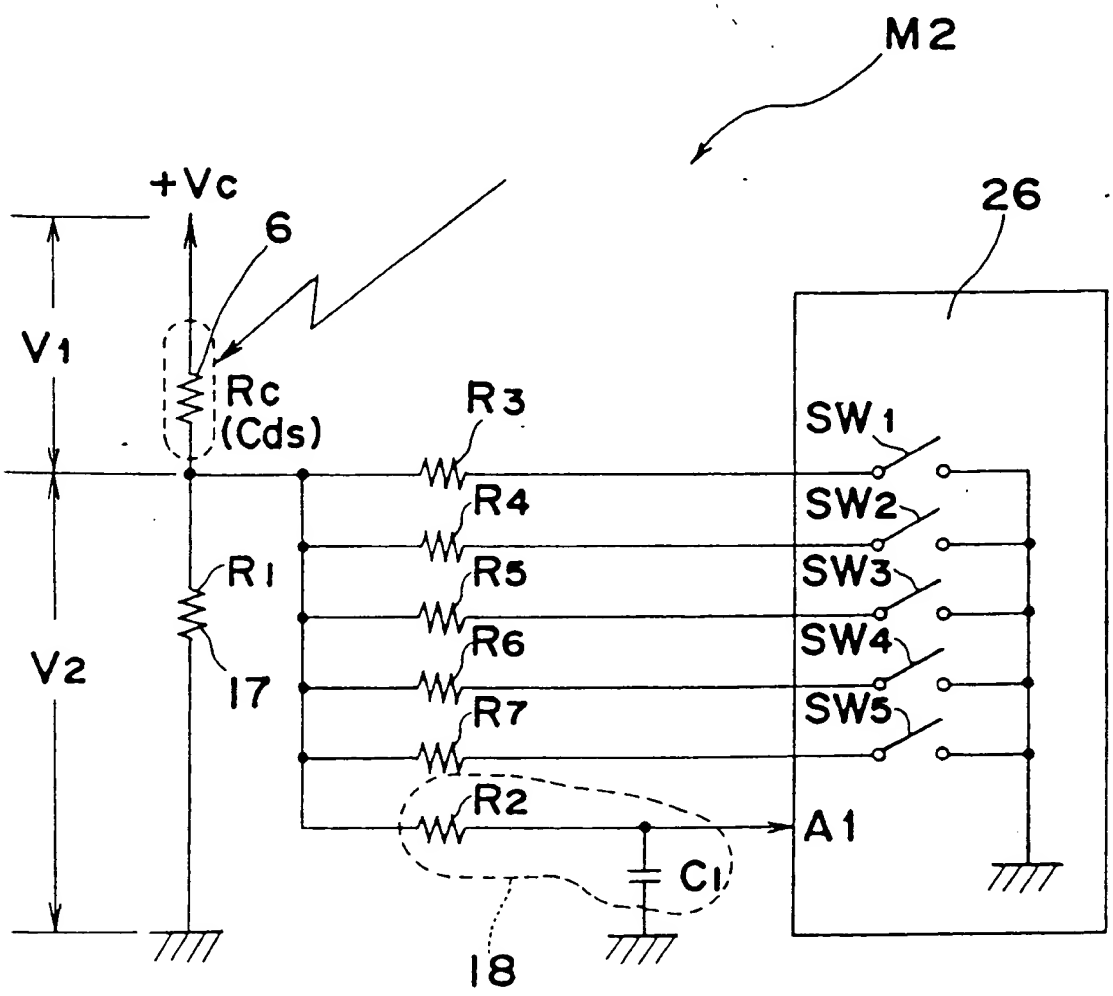
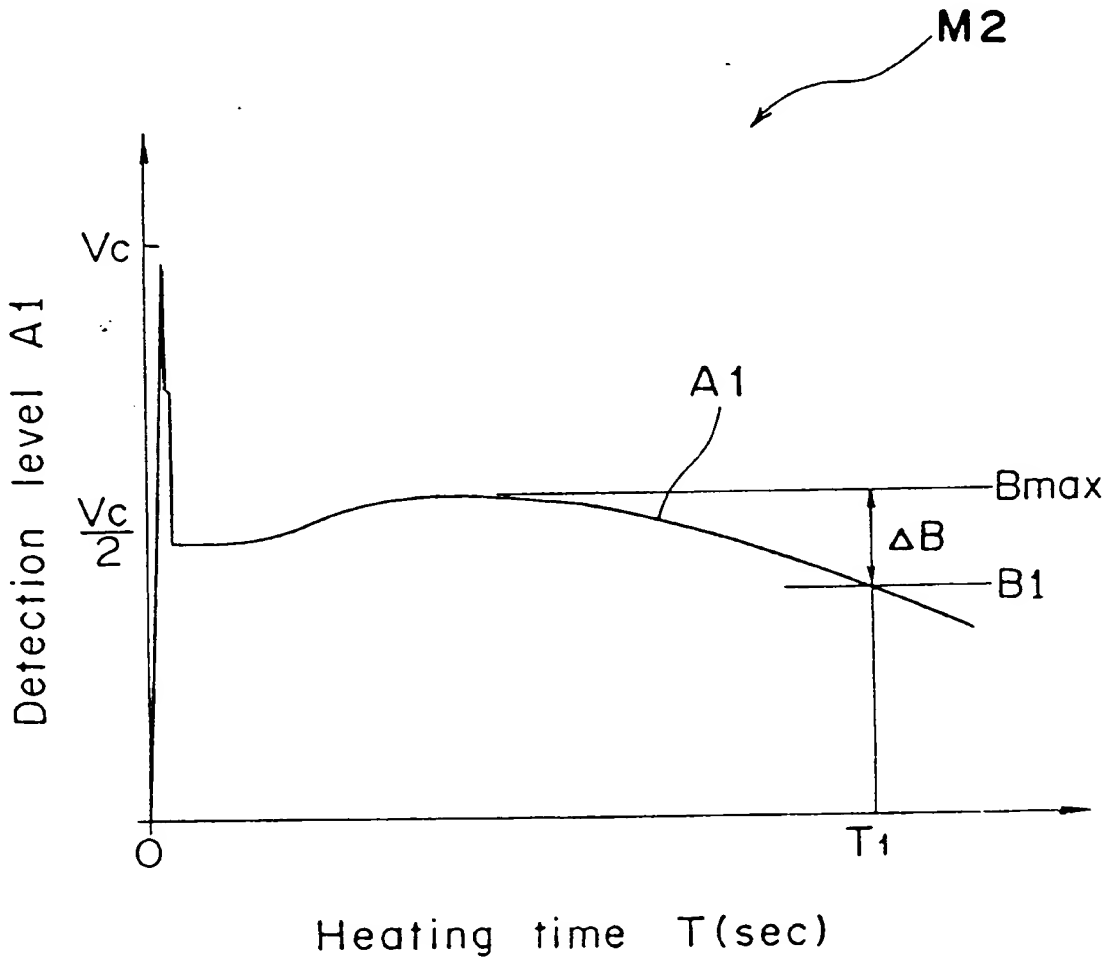

M2
+Vc
6
26
V1
Rc
(Cds)
R3
SW1
R4
SW2
R1
R5
SW3
V2
R6
SW4
17
R7
SW5
R2
A1
C1
18

Fig.6


M2
Vc
Vc/2
A1
Bmax
ΔB
B1
O
T1
Detection level A1
Heating time T(sec)